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ABSTRACT

The purpose of this report is to identify variables related to student achievement and to review the literature relative to those variables. First discussed are the unalterable variables--ability, socioeconomic status, and learning styles--which are related to student achievement but cannot be manipulated by educators. The rest of the report discusses alterable variables, or those which can be manipulated: time-on-task, formative and summative testing, mastery learning, cognitive entry characteristics, class size, motivation, and home-based reinforcement of school behavior. The paper concludes that the implementation of strategies designed to manipulate alterable variables or respond to unalterable variables should be supported by school policies, personnel, and budgets. (Author/LD)

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ALTERABLE VARIABLES IN EDUCATION

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Position Paper
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ALTERABLE VARIABLES IN EDUCATION

Recent extensive and cumulative reviews of educational research during the past twenty years has revealed several distinct variables which are consistently and significantly related to student achievement. The modern and powerful statistical procedures which have been applied to recent studies as well as the re-analysis of previous studies are yielding causal interpretations as opposed to the limited correlational interpretations of the past.

Some of these variables such as ability and socio-economic status are either unalterable unilaterally or at least unalterable by educators. Others of these variables, however, can be manipulated to a greater or lesser degree by educators. It is common in current literature (Bloom, 1980) to refer to these as "Alterable Variables". The purpose of this paper is (a) to identify and briefly review unalterable and alterable variables in the educational process; and (b) to recommend a course of action relative to such variables.

It is incumbent upon educators to identify and either compensate for or capitalize on the status of any unalterable variable in the educational process. It is equally incumbent upon educators to identify and manipulate any and all alterable variables in the educational process.

Unalterable Variables

Unalterable variables are defined (in the present context) as those variables which are significantly related to student achievement but cannot be manipulated by educators. The list of unalterable variables is extensive if not infinite. Some unalterable variables may have appropriate instructional responses. Tutoring, for example, appears to be a very effective instructional strategy for lower ability students. The use of advanced organizers, on the other hand, appears to be most effective with students of above average ability (Hartley and Davies, 1976). Other unalterable variables such as order of birth appear to have no appropriate pedagogical response. Unalterable variables may include abilities, learning styles, order of birth, handicaps (physical, social-emotional or intellectual) and socio-economic variables including father's occupation and income, father's education, mother's education and early parental emphasis on education (Shea, 1976).

Ability

Ability has been defined in a number of ways - some more useful than others. General intelligence or "I.Q.", except at the extremes where it is used for screening purposes, has not been found useful in educational programming (Glaser, 1976). The identification of specific academic abilities, however, can provide information about the learner to which educators can react appropriately (Hunt, et al, 1973). In addition to small group instruction and/or tutoring (Werts and Hilton, 1977), for example, below average ability students benefit from multisensory instructional programs whereas such programs do not appear to improve the achievement of above average students (Dunn, 1979). Preteaching of lesson content is also an effective instructional strategies with

below average ability students, while most instructional techniques employing advanced organizers such as pre-tests, conceptual models and comparison and contrast models appear to be most effective with above average ability students (Hartley and Davies, 1976).

While we should not be satisfied with low achievement in any form, we should take immediate corrective actions when a student's performance is below a level suggested by his/her "cognitive entry characteristics". Bloom (1980) concludes that cognitive entry characteristics including abilities or skills are important determinants of the learning of particular school subjects or tasks. We must, as a minimum standard, insist that students perform in a subject area commensurate with their abilities in that area.

Socio-Economic Status

While the schools can do little to alter such variables as family income, the integration of students of different socio-economic statuses (SES) appears to positively influence the academic achievement of below average SES students without altering the achievement level of above average SES students (Coleman et al, 1966). Further, there appears to be no unique or differentiation in instruction appropriate to variance in SES.

Learning Styles

Several different constructs of learning styles have been put forward in recent literature (Dunn and Dunn, 1979; Fischer and Fischer, 1979; Bennett, 1979; Joyce and Weil, 1971). The common conclusion is that students learn in a number of different and identifiable ways and that for each learning style there is an optimal instructional strategy or technique. While the learning styles of students are unalterable, the teaching strategies asso-

ciated with each learning style are readily variable and such alignment appears to be highly effective.

Alterable Variables

Alterable variables are defined as those variables which are significantly related to student achievement and which can be manipulated to a greater or lesser degree by educators. The list of alterable variables is by definition finite, since upwards from eighty per cent of the variance in student achievement is attributable to unalterable variables (Shea, 1976). This leaves relatively little room for a relatively few alterable variables to take effect. Alterable variables may include time-on-task, formative and summative testing, mastery learning techniques, cognitive entry level, class size, motivation/reinforcement, and consistency between the school and the home.

Time-on-Task

One of the least surprising yet most revolutionary findings in educational research during the past twenty years is the significance of time-on-task in relation to student achievement (Berliner, 1978, 1979; Cohen, 1974). Time-on-task is distinguished from time allotted to a task - the former referring to the amount of time a student spends actively engaged in learning tasks during a class period while the latter refers to the total time allotted in the schedule to the class period. It is clear that simply lengthening the school day (allotted time) is a false manipulation of the variable time-on-task. Time-on-task or "engaged time" needs to be attacked more directly. A considerable amount of manipulation of this variable appears to be within the powers of classroom teachers.

As early as 1967 Flanders concluded that changes in teacher classroom behaviors were generally accompanied by corresponding changes in student classroom behaviors. Extensive reviews have concluded that most teachers are able to change classroom behaviors that affect student time-on-task. It appears that teacher planning, grouping, classroom organization and management as well as the several components of mastery learning are structures which are highly susceptible to manipulation by classroom teachers (Cohen and Mueser, 1971). These structures in turn can increase student time-on-task and consequently improve student achievement.

Formative and Summative Testing

Bloom (1971) laid the theoretical foundation for formative and summative evaluation of student learning, claiming that accurate data, reflecting student status in relation to specific learning objectives, is an important factor in student achievement. In reporting the results of a large scale (400 schools/5 states) "Instructional Dimensions Study", Cooley and Leinhardt (1980) noted that ".... exact assessment of student mastery seems to be fairly important for student gain (p. 21)." Bloom has labeled this type of testing "formative evaluation" as opposed to end-of-course tests, final exams, etc. which he tags "summative evaluation".

Formative testing, of course, becomes more effective when followed-up by appropriate corrective procedures (Bloom, 1980), but may be effective even when used in isolation (Hartley and Davies, 1976; Cooley and Leinhardt, 1980). The most effective applications of testing, however, are in systematic designs such as mastery learning (Hunnes, 1978; Trogdon, 1980; Cohen and Mueser, 1971).

Mastery Learning

Mastery learning is not a single, neatly isolated variable. It is, rather, a collection of several effective components systematically arranged to facilitate learning and teaching (Block, 1973; Brandt, 1976). Some of these components include (a) task analysis or the specification of learning objectives; (b) diagnosis or criterion-referenced testing or, as Bloom labels it, formative evaluation; (c) classroom organization and management; (d) task differentiation including appropriately defined instructional groups ("teachable groups") and individualized learning experiences; and (e) assessment of mastery of specific learning objectives.

Some other variables which may be manipulated by educators in order to facilitate a mastery learning model are (a) time allowed for the learning of an objective; (b) mode of instruction and instructional materials; (c) dependency of instruction on personnel (e.g., teacher directed, tutor, independent learning activity, etc.) (Bloom, 1971, chpt. 3). Models of mastery learning appear feasible and appropriate at all levels of education.

Cognitive Entry Characteristics

While the manipulation of this variable is akin to a well-planned student placement policy, it goes somewhat further in seeking to identify "specific knowledge, abilities, or skills that are essential prerequisites for learning a particular school subject or a particular learning task (Bloom, 1980, P. 383)." Frazier's proficiency model identifies such skills as variables (as opposed to givens) in a student's prior training and suggests that either (a) such variables may be changed or brought up to criterion prior to tackling a particular learning task, or (b) the particular learning task may be delayed until the student has acquired such prerequisite skill or knowledge (Frazier, 1976, chpt. 3).

The evidence does suggest that students will learn a task more easily and more thoroughly when prerequisite learning and skills have been identified and certified. The structure of a curriculum and the classroom planning and instruction pursuant of the curriculum are vehicles by which educators can manipulate the variable of cognitive entry characteristics.

Class Size

Class size has been a long standing elusive variable as far as determining its effect on student achievement. Recent studies (Glass, 1979; Cohen and Filby, 1979) have concluded that class size does indeed relate to gains in student achievement as such sizes approach or become less than a threshold size of fifteen. Upon closer inspection, however, it appears that there are other variables, such as components of individualized instruction and mastery learning, which are simply more pervasive in smaller size classes. It is these components which appear to have the more direct impact on student achievement, while class size appears to be a facilitating variable which enables classroom teachers to implement effective instructional techniques.

While it may be unrealistic to seek class sizes of below fifteen students, some consistency and relative equity of class sizes among teachers is desirable. Such consistency at least enables classroom teachers to develop and implement mastery learning and classroom organization techniques that are most effective with classes of given sizes. Techniques that are effective with class sizes of twenty-one to twenty-five, for example, may not be adequate for classes of forty or more.

Reinforcement and Motivation

Reinforcement techniques and motivation to learn have perhaps been the subject of overkill in educational research. The net result on intrinsic motivation is that it is a weak correlate of learning (Uguroglu and Walberg,

1979). When motivation is stimulated by certain reinforcement techniques, however, learning may be significantly enhanced. Much of the cumulative and recent research on reinforcement as a variable in student achievement confirms Thorndike's classical laws of operant conditioning. Reinforcement appears to be most effective, for example, when the context of the learning situation is considered - that is, when the reinforcement for learning is closely associated with the learning task in context as well as temporally (Bates, 1979). Another way of saying this is that either the learning activity itself should provide reinforcement, or reinforcement should follow as a natural consequence of the learning activity. Bates (1979) calls these "natural reinforcers".

Bates (1979) also concludes that social reinforcers are more effective than token reinforcers (e.g., prizes). Also, natural social reinforcers, such as group learning activity, are more effective than post hoc social reinforcers such as allowing a student to choose a friend to play a game upon completion of a learning task.

Natural social reinforcers may be competitive (e.g., spelling bees) or cooperative (e.g., group projects). Contrary to much recent rhetoric, competition (individual/self, individual/others, group/group) can be a strong motivation to learning. Slavin concludes that "Mixtures of cooperative and competitive...reward structures appear to be the most promising avenues for producing positive effects...on academic achievement...(Slavin, 1977, p. 647).

Consistency Between the School and the Home

This variable is often referred to as "home-based reinforcement of school behavior" (Barth, 1979), home-school contracts, or home-school teaming models (Rich, et al, 1979). While there are many variations on this alterable variable, the basic element involves some form of contingency contracting (Homme, et al, 1969). Blechman (1977) has found consistently significant relationships between home-school contracting and gains in student performance on a longitudinal basis.

Summary and Recommendations

While an infinite number of factors affect and/or account for a student's educational achievement, teachers and schools should devote their energies to (a) implementing appropriate educational responses for those unalterable variables to which such responses exist, and (b) manipulating appropriately any and all alterable variables. Some brief possibilities are summarized below.

Ability: Specific subject area related abilities should be identified for all students. Differential instructional strategies corresponding to varying abilities should be implemented. Any discrepancy between a specific ability and performance in the corresponding subject area should be a priority for remediation. While homogeneous grouping is not advocated below grade seven, instructional arrangements should assure that each student is challenged within and to the limits of his or her abilities.

Learning Styles: Specific student learning styles should be identified. Teachers should receive training in a wide variety of appropriate instructional responses to such learning styles. Curricula should incorporate provisions for learning styles where appropriate.

Time-on-Task: This alterable variable should be studied thoroughly and understood by all educators. Teachers and administrators should be trained in those techniques and strategies of classroom and school organization and management which facilitate increased time-on-task. Curricula and programs should be designed and selected with time-on-task as a criteria.

Formative and Summative Testing: A well designed testing program should be implemented and its purposes and uses clearly understood by everyone in the school. School systems should invest in the technology which would enable every teacher to effectively and efficiently utilize tests in a formative manner.

Ideally, criterion-referenced tests should be given frequently during the year to determine readiness for and mastery of specific instructional objectives (formative) and also at the end of each year to determine retention of mastery and identify deficiencies. Standardized testing programs and criterion-referenced testing programs should stem from a systematic design of student and curriculum evaluation.

Mastery Learning: Teachers and administrators should be trained in the components and techniques of mastery learning. Building organizational patterns should facilitate mastery learning designs. Commitments to provide the instructional materials necessary for mastery learning designs should be made by school districts.

Cognitive Entry Characteristics: Prerequisite skills and knowledge should be more precisely identified for each learning objective and/or course. Student skill profiles of appropriate prerequisite skills (cognitive entry characteristics) should be maintained, and short term "remedial" learning arrangements should be arranged where appropriate. The curriculum should provide various paths by which students may acquire prerequisite skills for advanced courses (mobility).

Class Size: While it may be impossible to achieve class sizes approaching or below fifteen, efforts should be made to assure a year-to-year consistency of class size for various grade levels and courses.

Reinforcement and Motivation: The power of social reinforcement and natural reinforcers needs to be more clearly understood by all educators. Specific training in both the theory and implementation of such reinforcement in the classroom should be undertaken by school districts.

Consistency Between the School and the Home: Training for classroom teachers and administrators is, again, the key for making this alterable variable a reality.

Additionally, school structures should support this sort of activity so that the monitoring of contingency contracts does not simply become an additional burden for teachers. A considerable amount of parent education may also be in order for this variable.

Conclusions

If we can, through research and practice, identify significant variables which are related to student achievement and which either are capable of being manipulated by educators or have appropriate compensatory responses, then it is incumbent upon us to so manipulate and respond. Ten such variables have been reviewed in this paper. While this list is not exhaustive and there are certainly many other variables and components in the educational process that deserve attention and implementation, the alterable variables identified herein should serve as a basis for action. We should do those things which we know to be effective. We should use tools that work.

School systems should engage in training for alterable variables, first for awareness, then for methodology and techniques. Implementation of structures and strategies designed to manipulate alterable variables or respond to unalterable variables should be supported by school policies, personnel and budget.

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